

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
30 October 2003 (30.10.2003)

PCT

(10) International Publication Number
WO 03/089871 A1

- (51) International Patent Classification⁷: **F42B 5/16**, 14/00, 30/00
- (21) International Application Number: PCT/AU03/00318
- (22) International Filing Date: 17 March 2003 (17.03.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
PS 1828 19 April 2002 (19.04.2002) AU
- (71) Applicant (for all designated States except US): **METAL STORM LIMITED** [AU/AU]; Level 34, 345 Queen Street, Brisbane, Queensland 4000 (AU).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

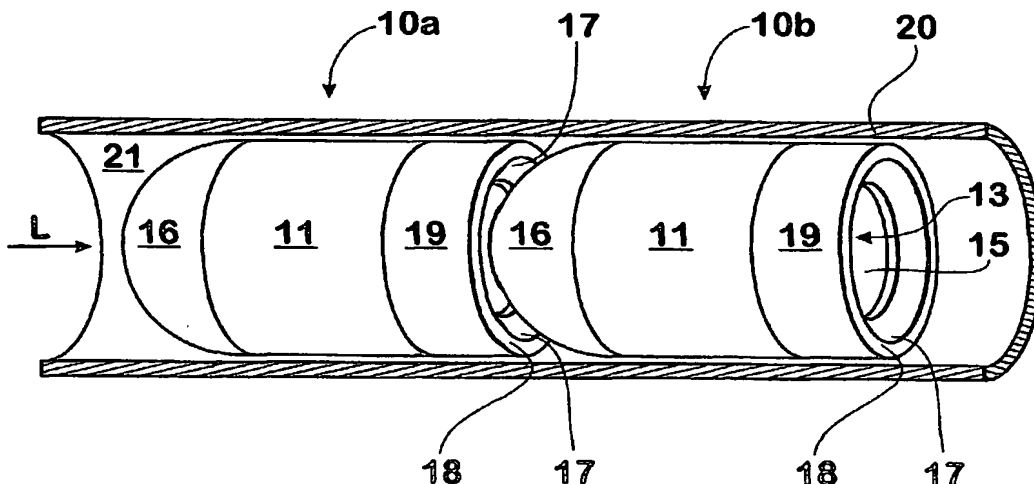
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **BAMBACH, Ramon, John** [AU/AU]; 3 Cameron Court, Victoria Point, Queensland 4165 (AU).
- (74) Agent: **DAVIES COLLISON CAVE**; 1 Little Collins Street, Melbourne, VIC 3000 (AU).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: PROJECTILE SEALING ARRANGEMENT



(57) Abstract: A projectile sealing arrangement for a barrel assembly of a weapon wherein a plurality of projectile assemblies (10) are axially disposed in abutting relationship within a barrel (20), each projectile assembly (10) including a body (11) associated with a discrete propellant charge (15); said sealing arrangement comprising rearward opening (13) communicating with cavity (14) provided in said projectile assembly (10) for retaining the discrete propellant charge (15) and a forward portion (16) of an abutting projectile arranged for operative sealing engagement with a complementary portion (17) of the rearward opening (13). The sealing arrangement suitably includes surface portions of complementary shapes such that, during application of a compressive load (L) to abutting projectile assemblies (10), discrete propellant charge (15) is sealed within the cavity (14). There is also disclosed and claimed a chain of individual projectiles connected head to tail by complementary spigot and socket members.

Best Available Copy

PROJECTILE SEALING ARRANGEMENT

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to projectile sealing arrangements for barrel assemblies wherein a plurality of projectile assemblies are disposed axially in abutting relationship within a barrel and associated with discrete propellant charges for selectively propelling respective projectiles sequentially from the barrel.

10 The invention relates particularly, although not exclusively, to barrel assemblies for weapons that employ electrical or electronic activation of ignition means for igniting the discrete propellant charges.

Discussion of the Background Art

The projectile sealing arrangements for barrel assemblies described in earlier
15 International Patent Applications assigned to the present applicant, including
PCT/AU94/00124, utilise operative sealing engagement between each projectile
assembly and the bore of a barrel containing the projectile assemblies.

20 An important function of operative sealing engagement between projectile assemblies and the barrel bore is to prevent or at least minimise burn leakage of combustion products resulting from firing a leading projectile, which leakage might otherwise cause sympathetic ignition of propellant charges associated with trailing projectile assemblies within the barrel. These projectile assemblies include a variety of barrel seal configurations incorporated in sabots and wedging sleeves, rings or expandable portions - all arranged to seal against the bore of the barrel.

25 However the relative complexity and cost of manufacturing barrel assemblies utilising operative sealing engagement with the barrel detracts from some applications of the applicant's barrel assemblies, especially where high volume, low cost manufacture is anticipated.

30 SUMMARY OF THE INVENTION

Object of the Invention

The invention aims, in certain embodiments, to provide a projectile sealing arrangement for a barrel assembly wherein projectiles are disposed axially in a barrel

so as to inhibit the action of firing a leading projectile from igniting the propellant of the rearward or trailing projectiles without a requirement for operative sealing engagement of projectiles with the barrel bore.

5 The invention also aims, in certain embodiments, to provide a projectile sealing arrangement for such barrel assemblies that is less complex, allows use of conventional rifling, facilitates reduced manufacturing cost or at least provides a useful choice.

Disclosure of the Invention

10 With the foregoing in view, this invention in one aspect resides broadly in a projectile sealing arrangement for a barrel assembly of a weapon wherein a plurality of projectile assemblies are axially disposed in abutting relationship within a barrel, each projectile assembly associated with a discrete propellant charge; said sealing arrangement comprising:

15 a rearward opening communicating with a cavity provided in each projectile assembly for containing the discrete propellant charge; and

a forward portion of an abutting projectile assembly arranged for operative sealing engagement with the rearward opening;

20 the arrangement being such that, during application of a compressive load to abutting projectile assemblies, the discrete propellant charge is sealed within the cavity.

In another aspect, the present invention resides in a barrel assembly for a weapon; said barrel assembly including:

25 a plurality of projectile assemblies axially disposed in abutting relationship within a barrel, each projectile assembly associated with a discrete propellant charge;

ignition means for each propellant charge, whereby the discrete propellant charges may be selectively ignited to propel respective projectiles sequentially from the barrel; and

30 a sealing arrangement between abutting projectile assemblies, said sealing arrangement comprising:

a rearward opening communicating with a cavity provided in each projectile assembly for receiving the discrete propellant charge; and

a forward portion of an abutting projectile assembly arranged for operative sealing engagement with the rearward opening;

the sealing arrangement being such that, during the application of a compressive load to the abutting projectile assemblies, the discrete propellant charges for trailing projectiles are sealed within their respective cavities.

In a further aspect, the invention resides in a projectile assembly having a body with a head and a tail portion and characterised in that:

the head includes a forward portion arranged for operative sealing engagement with the rearward opening of a leading projectile;

the tail portion includes a rearward opening communicating with a cavity provided in the projectile assembly for receiving the discrete propellant charge, which opening includes a rear portion arranged for operative sealing engagement with the forward portion of a trailing projectile; and

a sealing arrangement being such that, during the application of a compressive load to abutting projectile assemblies, the discrete propellant charge is sealed within the cavity.

Preferably the forward or head portion has a forward sealing surface of a predetermined shape, and the rearward opening has a rearward sealing surface of a substantially complementary shape to the predetermined shape of the forward sealing surface, whereby the sealing surfaces cooperate.

Alternatively, either or both of the forward portion and the rearward opening include a sealing means, such as a gasket, to aid or enhance sealing. The sealing means may be pre-formed as a resilient body, such as a gasket, or formed in-situ through the use of a suitable flowable sealing material. Most preferably, the sealing material has adhesive properties.

The sealing surfaces of the projectile body may be of any suitable shape, including hemispherical, conical or wedge cross-sectional shaped surface portions, whether dictated by aerodynamic considerations or otherwise. Suitably, the forward sealing surface has a convex shape and the cooperating rearward sealing surface has a complementary concave shape.

The projectile body may include a transverse surface on one of the head and tail portions of the projectile assemblies, which transverse surface is arranged to prevent over-travel of a projectile relative to its trailing projectile upon application of compressive loads thereto. The transverse surfaces may be planar or curved, as
5 required.

The propellant charges may be provided in a solidified form or a flowable form, such as powder or granules.

The rearward opening may include a closure for retaining the propellant material within the cavity. The closure may comprise a mechanically burstable disc
10 or a disc composed of combustible material.

The closure may include retaining means that releasably engage with complementary retaining means on the head. The retaining means suitable socket and spigot members that desirably include cooperating screw threads to convenient facilitate release. Alternatively the retaining means may be frangible. In either case
15 a chain of projectile assemblies may be formed by selective engagement of such retaining means.

In a still further aspect, the invention resides in a chain of projectiles including at least two projectiles releasably coupled together, wherein each projectile assembly
20 comprises a head portion and a tail portion and wherein a releasable coupling comprises a complementary spigot member and socket member, which coupling is disposed between the tail portion of a leading projectile and a head portion of a trailing projectile.

If required the spigot member and socket member of the coupling are provided
25 with releasable engagement means, such as cooperating screw threads or frangible joint means.

BRIEF DETAILS OF THE DRAWINGS

In order that this invention may be more readily understood and put into
30 practical effect, reference will now be made to the accompanying drawings that illustrate typical embodiments of the invention, wherein:

FIG. 1 is an isometric view of a projectile assembly of a first embodiment of the invention;

FIG. 2 is a partially fragmented isometric view of two projectile assemblies of the first embodiment in almost abutting relation within a barrel;

FIG. 3 is an isometric view of a projectile assembly of a second embodiment of the invention;

5 FIG. 4 is a partially fragmented isometric view of two projectile assemblies of the second embodiment;

FIG. 5 is an isometric view of projectile assemblies including a sealing arrangement of a third embodiment of the invention;

10 FIG. 6 is a sectional side elevational view of a projectile assembly of a fourth embodiment of the present invention;

FIG. 7 is a further section side elevational view of a projectile assembly of abutting projectiles of the fourth embodiment;

FIG. 8 is a sectional side elevational view of a projectile assembly of a fifth embodiment of the present invention; and

15 FIG. 9 is a further section side elevational view of a projectile assembly of abutting projectiles of the fifth embodiment.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

20 The projectile assemblies 10 of the first embodiment illustrated in FIGs 1 and 2 each include a body 11 having a head or forward portion 12 and a mouth or rearward opening 13 at a tail portion 19, which opening communicates with a cavity 14 provided in the projectile body. The cavity 14 contains a discrete propellant charge 15 together with ignition means (not shown) for igniting the propellant charge. It will be appreciated that upon ignition of the propellant, suitably by electronic control
25 means, combustion products including propellant gas will exit the projectile cavity 14 via the mouth 13 at the tail 19 of the projectile with considerable force.

In the first embodiment, a forward sealing surface 16 of the projectile head 12 is convex, having a simple hemispherical shape, whilst the mouth 13 has a peripheral sealing surface 17 that is provided or formed, at least in part, with a complementary
30 concave shape to the hemispherical sealing surface 16 of head 12. The precise configuration of the shapes are relatively unimportant, other than the requirement that they be complementary in order to satisfy the desired purpose of providing a substantially gas tight seal upon application of a compressive load to abutting

projectile assemblies. Such a seal is intended to avoid inadvertent ignition of propellant associated with trailing projectiles, as discussed in relation to FIG 2. It is also desirable that the shapes utilised for the projectile provide sufficient strength to withstand the in-barrel forces that arise during firing of a weapon utilising the projectile assemblies.

Whilst a simple hemispherical shape is employed in this embodiment, many variations to this are possible. For example, one simple variation is the projectile head and the receiving tail of the projectile have cooperating conical or wedge cross-sectional shapes for improved sealing engagement. In some embodiments, the surface shape of the head or forward portion 12 of the projectile body 11 will be determined in accordance with aerodynamic considerations.

FIG. 2 illustrates two(2) of a plurality of projectile assemblies 10 axially disposed in nearly abutting relation within a barrel 20. The projectile assemblies are slightly separated and only a fragment of the barrel 20 is depicted for reasons of clarity. In normal operation, the forward surface 16 of the head 12 of the leading or left-hand projectile 10a would be in contact with the rearward peripheral surface 17 of the mouth 13 of the trailing or right-hand projectile 10b, due to the compressive action of loading projectiles into the barrel 20. The peripheral surface 17 extends inwardly of each projectile 10, both from a rear end annular face 18 at the tail of the projectile and from an outer surface of the projectile body 11 toward the longitudinal axis 22 of the projectile.

Upon the application of compressive load L to the abutting projectiles 10, the rearward peripheral surface 17 of the leading projectile 10a is operatively sealed against the forward surface 16 of the trailing projectile 10b, thereby sealing the propellant charge 15 within the cavity 14 in the projectile body 11. Typically further compressive loading results from ignition of a forwardmost projectile (not shown in FIG. 2) during the propulsion of the forwardmost projectile from the barrel 20.

It should be noted that the interaction between the projectile assemblies 10 and the wall or bore 21 of the barrel 20 of the present embodiment, at least insofar as any requirement for sealing is concerned, is the same as that for conventional projectiles and barrel walls in known weapons. Thus only a level of sealing between the outer cylindrical surface of the projectile body 11 and the barrel bore 21 which inhibits propellant gases from escaping past the head 12 of the projectile body 11

during firing, such as provided by conventional rifling, is necessary for reliable operation.

A projectile 30 in accordance with the second embodiment of the invention is illustrated in FIG. 3. The projectile 30 includes a body 31 having a reduced diameter head or forward portion 32 and a mouth or rearward opening 33 at a tail portion which mouth communicates with a cavity (not shown) provided in the projectile body. The projectile body 31 includes a frustro-conical tail portion 34 which terminates at an annular rear face 38 having a reduced diameter relative to the projectile body generally. The internal cavity contains a discrete propellant charge 35 together with ignition means (not shown) for igniting the propellant charge. The arrangements for igniting the propellant charge may suitably be similar to those described in the earlier International Patent Application PCT/AU94/00124, assigned to the present applicant.

A forward sealing surface 36 is provided on the projectile head, together with a complementary rearward sealing surface 37 at the periphery of the rearward opening 33, which is arranged for operative sealing engagement with the sealing surface 36 of projectile head 32.

FIG. 4 illustrates two(2) projectiles 30 of a second embodiment in substantially axial alignment, although they are spaced in the drawing apart for clarity. If required, a front face of the projectile body 31 may include an annular portion (not shown) transverse to a longitudinal axis 39 and arranged to abut the transverse, annular rear end face 38 of a leading projectile. This arrangement might be provided to limit the travel of the head 32 of a trailing projectile into the rearward mouth 33 of a leading projectile, thus minimising the possibility of the respective sealing faces 36, 37 becoming locked together through over-travel and/or deformation caused by repeated application of compressive forces to a chain or stack of projectile assemblies in a barrel.

Turning to FIG. 5, there is shown projectile assemblies 40 of generally similar configuration to that described above in relation to FIGs 1 and 2. Each projectile assembly 40 includes a sealing means in the form of a gasket 41 retained on the rearward sealing surface 42 of an opening 43 adjacent the projectile tail portion 49. This first gasket 41, which may be composed of stainless steel or a suitably specified synthetic material, provides for enhanced sealing between the rearward sealing surface 42 and the forward sealing surface 44 of the projectile head. A double seal

may be achieved, if required, by providing a second gasket (suitably spaced from the first gasket 41) on the projectile head. However, sealing means disposed on the projectile head can detract from the aerodynamic performance of the projectile assembly 40.

5 In other variations of the third embodiment, the sealing means may comprise an adhesive sealing material that forms a seal between abutting projectile assemblies in situ, and might also function to retain a plurality of projectiles in a chain for ease of loading into a barrel. A propellant charge 45 is retained with the body of the projectile assembly 40, and may be formed as a solid block or as flowable
10 material, such as powder or granules, as in the present embodiment.

This embodiment further includes a closure for the rearward opening 43, in the form of a burstable disc 46, for retaining the flowable propellant charge 45. The closure, which may alternatively be formed of a combustible material rather than a burstable disc, includes retaining means that releasably engage with complementary
15 retaining means on an adjacent projectile head. The retaining means in the present embodiment are formed by a spigot member 47 on the head, and by a socket member 48 provided in the burstable disc 46, which members each include respective cooperating screw-threads allowing subsequent release as desired. In other embodiments using a solid block of propellant, retaining means may include a
20 socket formed directly in the propellant block.

The spigot and socket members 47, 48 of the retaining means may together comprise a frangible coupling. Rather than cooperating threads, the coupling may be released with the assistance of combustion, most desirably that present during firing. A plurality of projectile assemblies 40 can accordingly be coupled together to form a
25 chain of projectiles for ease of handling and subsequent loading into a barrel.

FIGs 6 and 7 illustrate, in cross-section, projectiles 50 of a fourth embodiment of the invention. The projectile 50 shown in FIG. 6 includes an outer wall 51 defining an internal cavity and a transverse inner wall 52 dividing the cavity into a cargo or payload cavity 53 and a propellant cavity 54. The projectile body may be notionally
30 divided into a head portion 55 and a tail portion 56 for ease of reference.

The forward external surface of the head portion 55 includes a flattened or truncated forward end 56 and a convex sealing surface 57. An inner surface of the head portion includes an inwardly extending strengthening rib 58 for the cargo or

payload cavity 53. It will be appreciated that the rib 58 may, in one form, include a screw-thread arrangement for facilitating access to the payload cavity, as required.

The propellant cavity 54 can communicate externally of the projectile via a rearward mouth or opening 59 at the tail portion 56 of the projectile, which mouth is defined by an inwardly extending annular wall 60. The opening 59 is covered by a closure, here in the form of a burstable disc 61, adapted for rupture upon ignition of the flowable propellant (not shown) contained therein. A rearward sealing surface 62 of the annular wall 60 has a concave shape which is generally complementary to the convex sealing surface 57.

Turning to FIG. 7 which shows a stack of three(3) projectiles 50a, 50b, 50c of the fourth embodiment, arranged in axially abutting relation as disposed in a barrel (not shown). Accordingly, the propellant cavity 54a of the first projectile 50a is sealed at interface 65a-b formed by cooperation of the rearward sealing surface 62a of the first projectile with the forward sealing surface 57b of the next adjacent (second) projectile 50b. In turn, the propellant cavity 54b of the second projectile 50b is sealed at interface 65b-c formed by cooperation of its rearward sealing surface 62b with the forward sealing surface 57c of the next adjacent (third) projectile 50c.

FIGs 8 and 9 illustrate, in cross-section, projectiles 70 of a fifth embodiment of the invention. The projectile 70 shown in FIG. 8 includes an outer wall 71 defining an internal cavity and a transverse inner wall 72 dividing the internal cavity into a cargo or payload cavity 73 and a propellant cavity 74. The projectile body may again be notionally divided into a head portion 75 and a tail portion 76 for ease of reference.

The forward outer surface of the head portion 75 includes a transverse annular surface 76, located at the transition from a cylindrical side wall to a partially spherical front wall of the head portion 75, said front wall having a forward convex sealing surface 77. An inner surface of the head portion 75 of projectile 70 includes an inwardly extending strengthening rib 78 for the cargo or payload cavity 73.

The propellant cavity 74 can communicate externally of the projectile via a rearward mouth or opening 79 at the tail portion 76 of the projectile, which mouth is defined by an inwardly extending annular wall 80. A solidified block of propellant 81 (shown in phantom) may be contained in the propellant cavity 74. A rearward sealing surface 82 of the annular wall 80 has a concave shape which is generally complementary to the convex, spherical, sealing surface 77.

Turning to FIG. 9 which shows a stack of three(3) projectiles 70a, 70b, 70c of the fifth embodiment, arranged in axially abutting relation as stacked in a barrel (not shown). Accordingly, the propellant cavity 74a of the first projectile 70a is sealed at interface 85a-b formed by cooperation of the rearward sealing surface 82a of the first projectile 70a with the forward sealing surface 77b of the next adjacent (second) projectile 70b. It will also be seen that the abutment between a rearward corner 83a and the lateral annular face 76b of respective first and second projectiles resists over-travel and possible deformation of the projectiles 70a, 70b during axial compression of the projectile stack.

In turn, the propellant cavity 74b of the second projectile 70b is sealed at interface 85b-c formed by cooperation of its rearward sealing surface 82b with the forward sealing surface 77c of the next adjacent (third) projectile 70c. Similarly, over-travel is resisted by abutment of the rearward corner 83b of the second projectile 70b by the forward lateral face 76c of the third projectile 70c.

The present invention finds application in weapons for both military and law enforcement uses, although this invention is also applicable for other civilian uses. It has particular application to weapon systems in that it greatly reduces the stress requirements of the barrel and projectile, which also simplifies the manufacturing process. In particular, projectiles including the sealing arrangement of the invention may be utilised with barrels that employ standard construction techniques, including conventional rifling arrangements, as well as with more specialised barrels and weapons.

It is to be understood that the above embodiments have been provided only by way of illustration of this invention and that further modifications and improvements thereto, as would be apparent to persons skilled in the relevant art, are deemed to fall within the broad scope and ambit of the present invention described herein and defined in the claims that follow.

CLAIMS

1. A projectile sealing arrangement for a barrel assembly of a weapon wherein a plurality of projectile assemblies are axially disposed in abutting
5 relationship within a barrel, each projectile assembly associated with a discrete propellant charge; said sealing arrangement comprising:

a rearward opening communicating with a cavity provided in each projectile assembly for containing the discrete propellant charge; and

10 a forward portion of an abutting projectile assembly arranged for operative sealing engagement with the rearward opening;

the arrangement being such that, during application of a compressive load to abutting projectile assemblies, the discrete propellant charge is sealed within the cavity.

15 2. The projectile sealing arrangement of claim 1 wherein the forward portion of each projectile assembly has a forward sealing surface of a predetermined shape, and the rearward opening has a rearward sealing surface of a complementary shape to the predetermined shape of the forward sealing surface.

20 3. The projectile sealing arrangement of claim 1 wherein either or both of the forward portion and the rearward opening include a sealing means to aid or enhance sealing.

25 4. The projectile sealing arrangement of claim 3 wherein the sealing means is pre-formed as a resilient body.

5. The projectile sealing arrangement of claim 3 wherein the sealing means is formed in-situ through the use of a suitable sealing material.

30 6. The projectile sealing arrangement of either claim 4 or claim 5 wherein said sealing means has adhesive properties.

7. The projectile sealing arrangement of claim 1 wherein the sealing surfaces include planar surface portions.

8. The projectile sealing arrangement of claim 1 wherein the sealing surfaces include hemispherical shaped surface portions.

9. The projectile sealing arrangement of claim 1 wherein the sealing surfaces include conical shaped surface portions.

10. The projectile sealing arrangement of any one of claims 7 to 9 wherein shapes of said sealing surfaces are dictated by aerodynamic considerations.

11. A barrel assembly for a weapon; said barrel assembly including:
a plurality of projectile assemblies axially disposed in abutting relationship within a barrel, each projectile assembly having a head portion and a tail portion and is associated with a discrete propellant charge;

ignition means for each propellant charge, whereby the discrete propellant charges may be selectively ignited to propel respective projectiles sequentially from the barrel; and

a sealing arrangement between abutting projectile assemblies, said sealing arrangement comprising:

a rearward opening communicating with a cavity provided in the body of each projectile assembly for receiving the discrete propellant charge; and

a forward portion of an abutting projectile arranged for operative sealing engagement with the rearward opening;

the sealing arrangement being such that, during the application of a compressive load to the abutting projectile assemblies, the discrete propellant charges for trailing projectiles are sealed within their respective cavities.

12. The barrel assembly of claim 11 wherein the projectile body includes a transverse surface on at least one of the head and tail portions of the projectile assemblies, which transverse surface is arranged to prevent over-travel of a

projectile relative to a trailing projectile upon application of an axial compressive load to said plurality of projectiles.

13. The barrel assembly of claim 11 wherein propellant charges are in
5 solidified form.

14. The barrel assembly of claim 11 wherein propellant charges are in a flowable form.

10 15. The barrel assembly of either claim 13 or claim 14 wherein the rearward opening includes a closure for retaining the propellant material within the cavity.

16. The barrel assembly of claim 15 wherein the closure comprises a burstable disc or a disc composed of combustible material.

15 17. The barrel assembly of claim 16 wherein said closure includes retaining means for releasable engagement with complementary retaining means on the head portion of an adjacent projectile assembly.

20 18. The barrel assembly of claim 17 wherein said complementary retaining means include a socket member and a spigot member.

22. The barrel assembly of claim 17 wherein said complementary retaining means include cooperating screw threads to facilitate release.

25 20. The barrel assembly of claim 17 wherein the retaining means is frangible.

21. A projectile assembly having a body with a head and a tail portion, said
30 projectile assembly characterised in that:

the head includes a forward portion arranged for operative sealing engagement with the rearward opening of a leading projectile;

the tail portion includes a rearward opening communicating with a cavity provided in the projectile assembly for receiving the discrete propellant charge, which opening includes a rear portion arranged for operative sealing engagement with the forward portion of a trailing projectile; and

5 a sealing arrangement being such that, during the application of a compressive load to abutting projectile assemblies, the discrete propellant charge is sealed within the cavity.

10 22. A chain of projectiles including at least two projectiles assemblies coupled together by a coupling, wherein each projectile comprises a head portion and a tail portion and wherein the coupling comprises a complementary spigot member and socket member, which coupling is disposed between the tail portion of a leading projectile and a head portion of a trailing projectile.

15 23. The chain of projectiles as claimed in claim 22 wherein the spigot member and socket member of the coupling are provided with releasable engagement means.

20 24. The chain of projectiles as claimed in claim 22 wherein the coupling includes frangible retaining means.

1 / 5

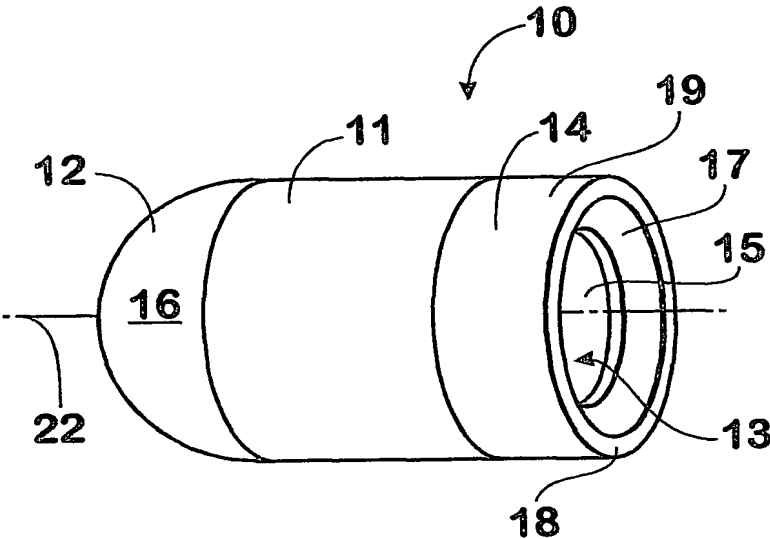


Fig. 1

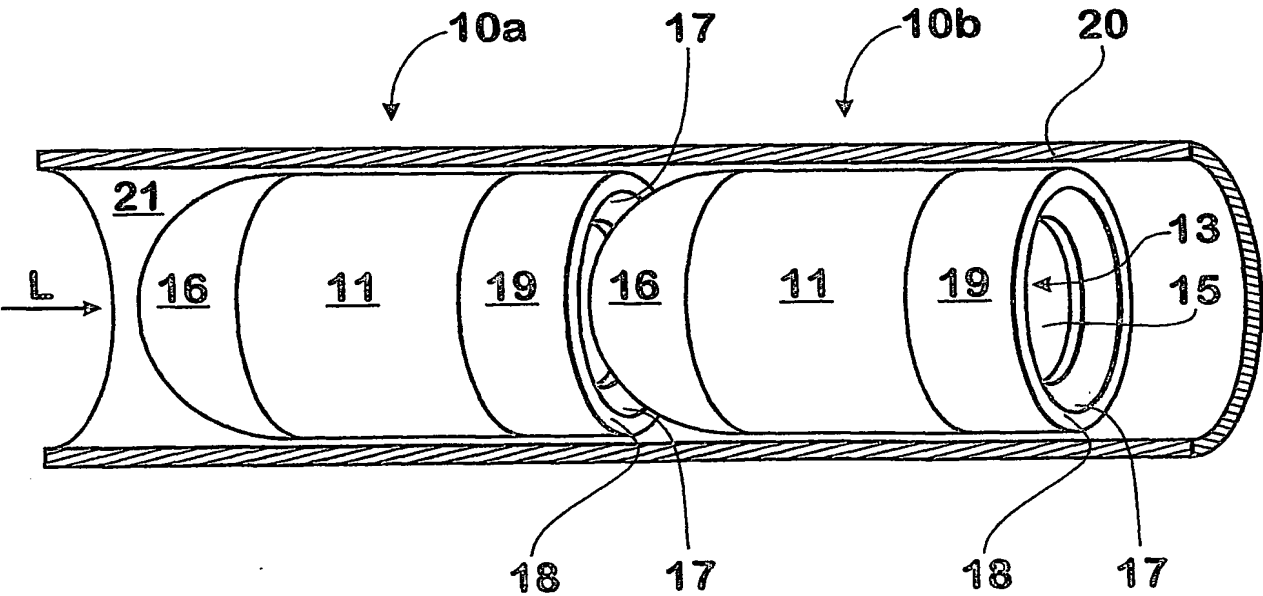


Fig. 2

2 / 5

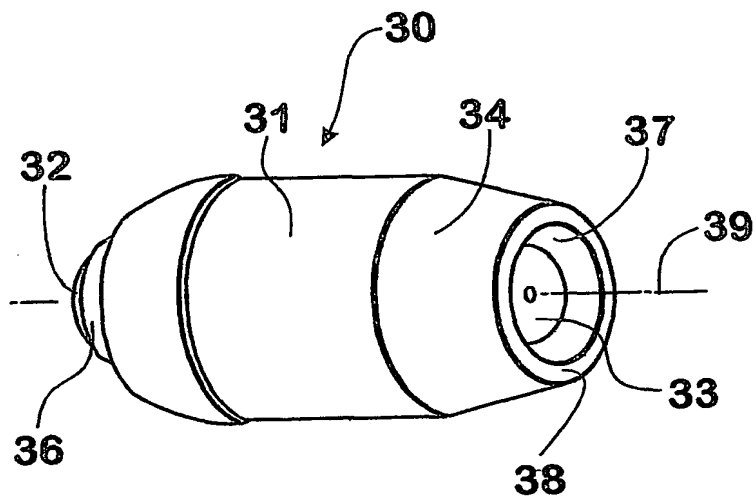


Fig. 3

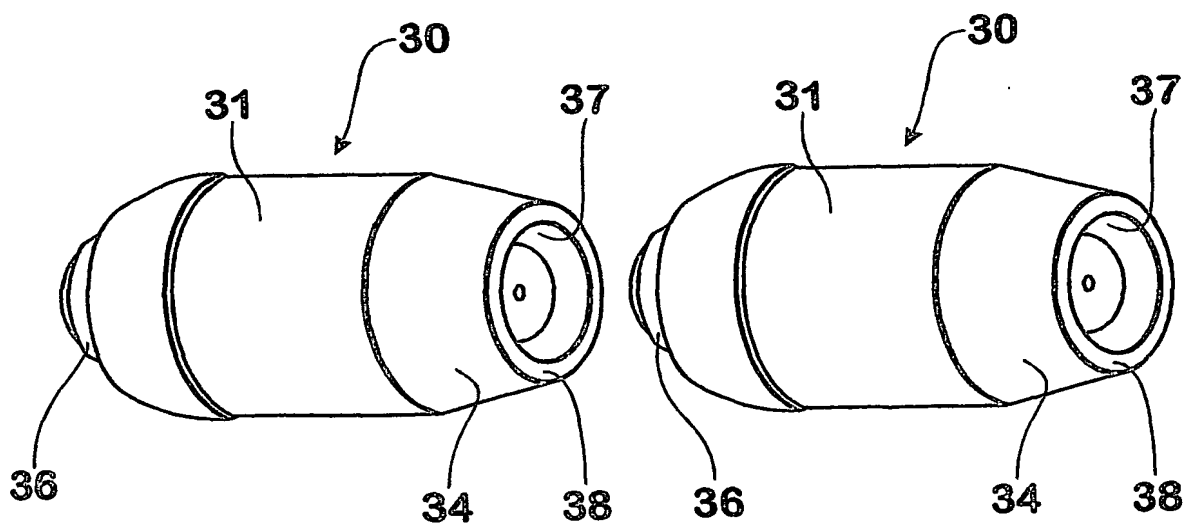


Fig. 4

3 / 5

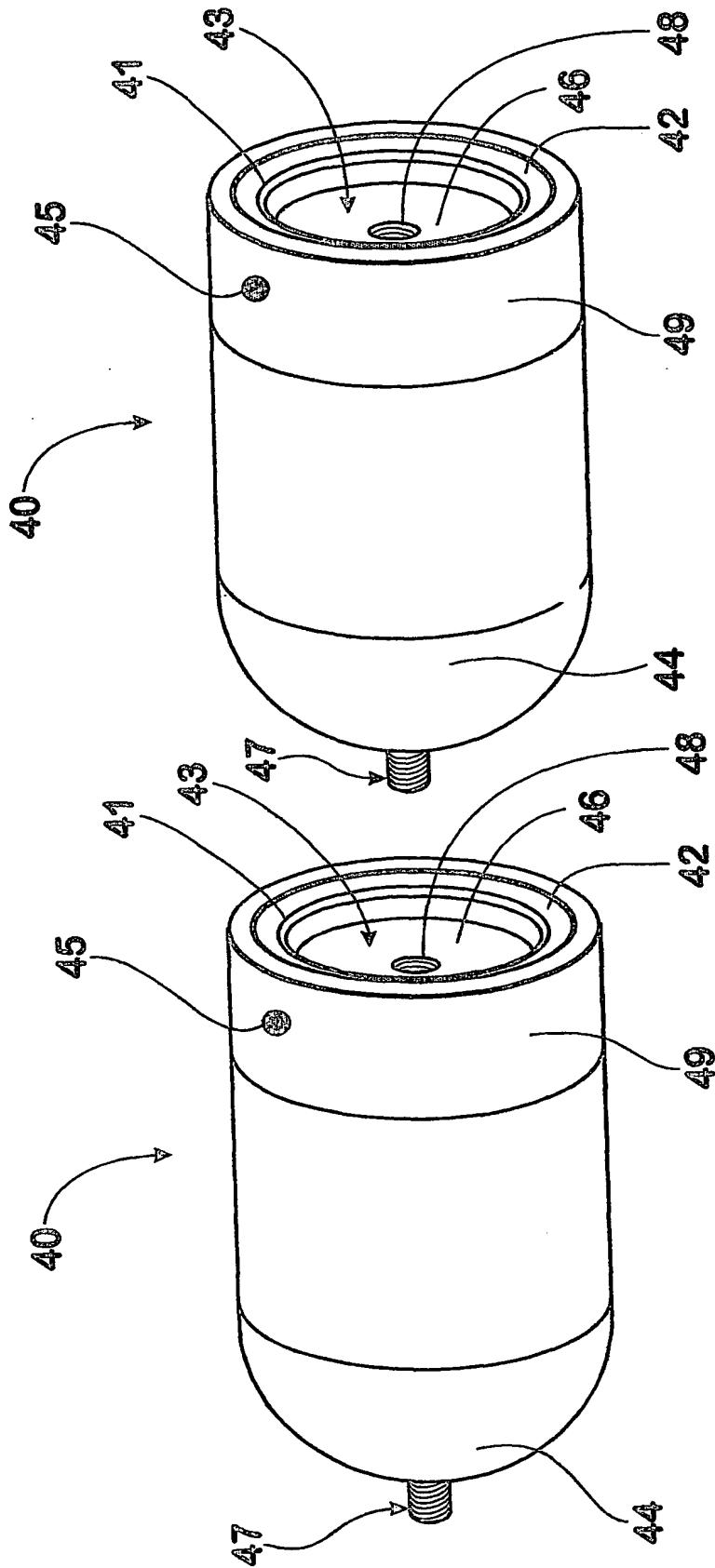


Fig. 5

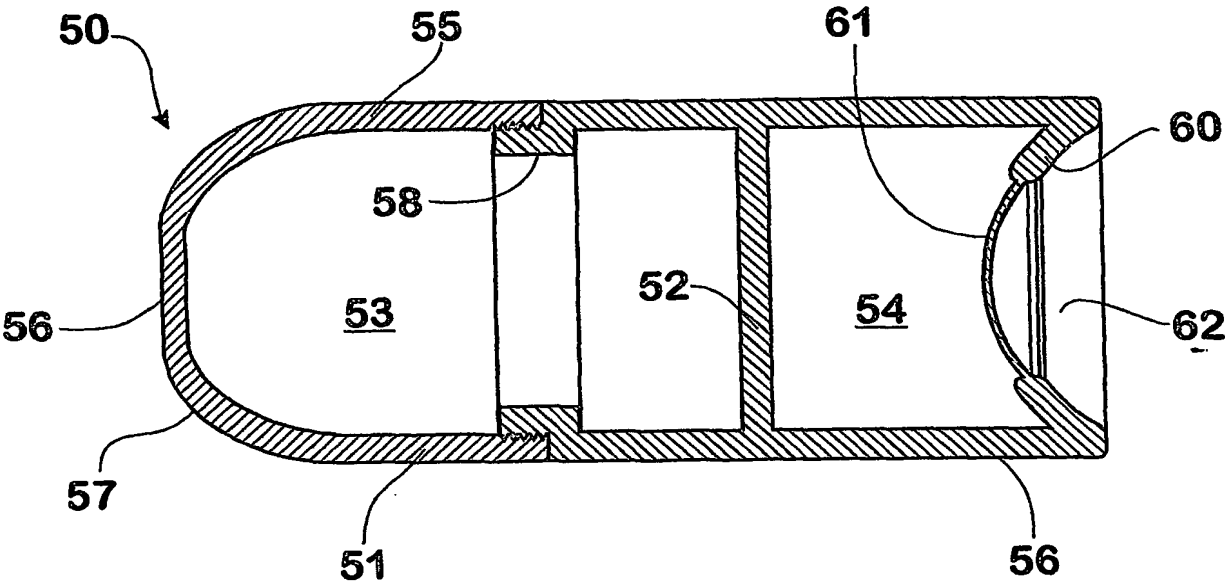


Fig. 6

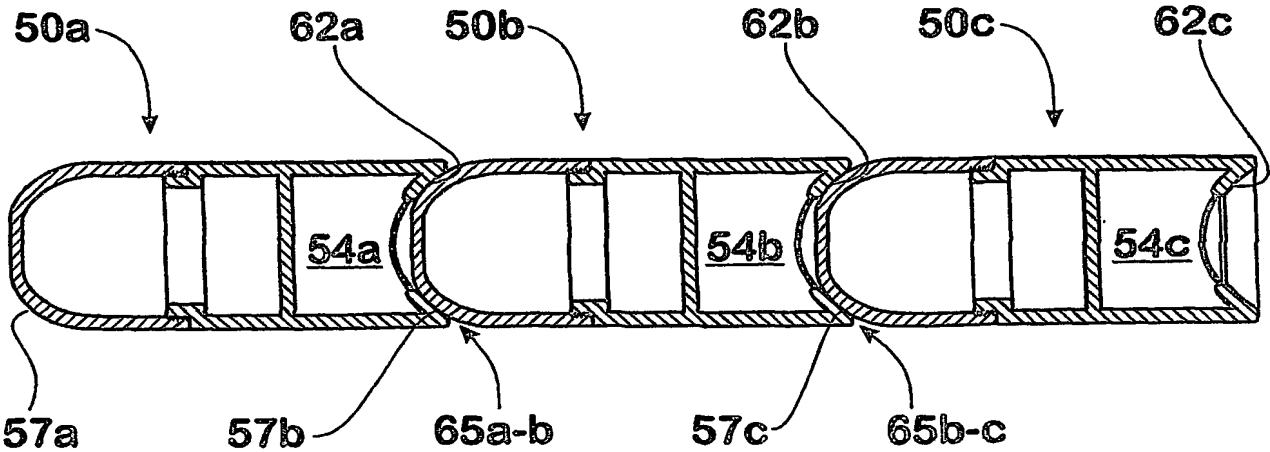


Fig. 7

5 / 5

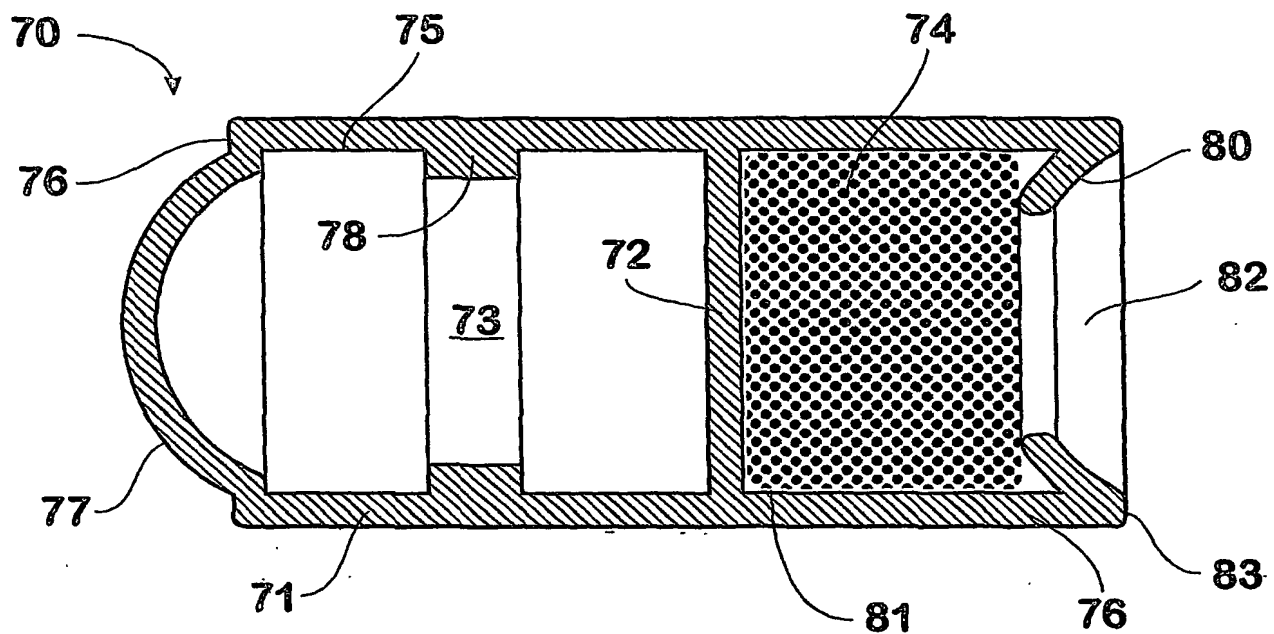


Fig. 8

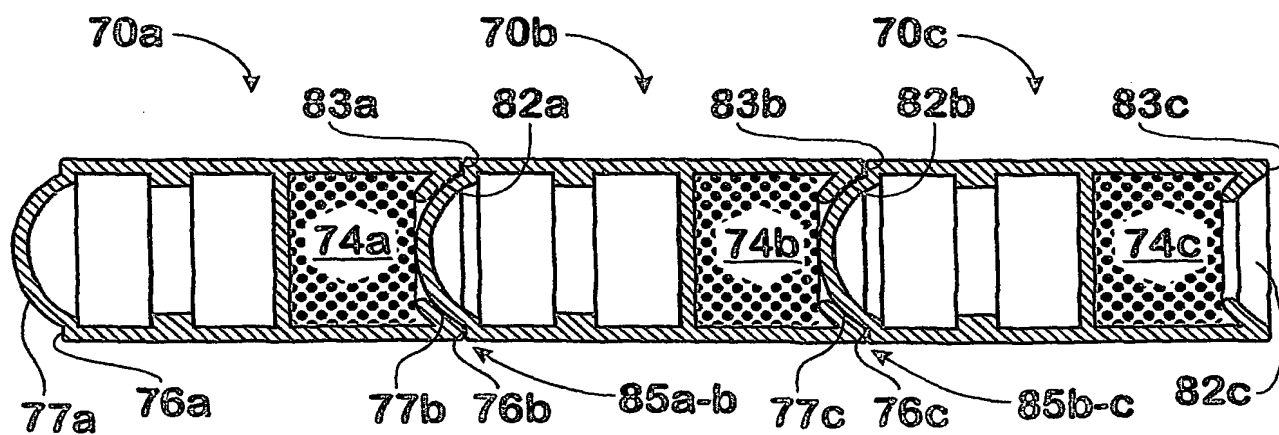


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/00318

A. CLASSIFICATION OF SUBJECT MATTER												
Int. Cl. ⁷ : F42B 5/16, 14/00, 30/00												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols)												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
AU: IPC F42B 5/02, 5/16, 14/00, 30/00, 39/26												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)												
DWPI: Q79/DC with keywords such as projectile, cavity, propellant, seal, chain, couple and similar terms.												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	GB 1594686 A (RHEINMETALL GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG) 5 August 1981 Figure 3	1-3, 8, 9, 11-15, 21										
X	AU 62790/94 A (O'DWYER) 26 September 1994 Figure 5	1-3, 8, 9, 11-15, 21										
X	AU 76309/98 A (O'DWYER) 21 December 1998 Figure 2A	1-3, 8, 9, 11-15, 21										
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 9 May 2003		Date of mailing of the international search report 16 MAY 2003										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer JEFFREY CARL Telephone No : (02) 6283 2543										

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/00318

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2099993 A (TAUSCHEK) 23 November 1937 Figure 9	22-24
A	AU 200045232 A (METAL STORM LIMITED) 14 November 2000	
A	AU 200035451 A (METAL STORM LIMITED) 14 November 2000	
A	US 3854231 A (BROYLES) 17 December 1974	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/00318

Box I Observations where certain claims were found unsearchable (Continuation of Item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-21 directed to projectile sealing arrangements and projectile assemblies for a plurality of axially disposed abutting projectiles, the projectiles being characterised by the forward portion of a trailing projectile being in operative sealing engagement with a recess in the trailing portion of a leading projectile.
 2. Claims 22-24 directed to a chain of projectiles characterised by a trailing projectile having a head portion for engagement with a complementary recess in the tail portion of a leading projectile such that the projectiles are coupled together in a spigot and socket coupling.
-
1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
 2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
 3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

 4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU03/00318

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
GB	1594686	DE	2723621		
AU	62790/94	AU	23651/97	AU	48863/99
		CA	2157882	CN	1120863
		EP	1069394	HU	72876
		US	5883329	US	6123007
		WO	94/20809	WO	2003023309
AU	76309/98	AU	75148/98	AU	75149/98
		BR	9812999	BR	9813000
		EP	985128	EP	985130
		US	2002152918	US	2002157526
		WO	98/55824	WO	98/55825
AU	200045232	AU	200214774	BR	200011194
		EP	1175589	WO	00/62005
AU	200035451	AU	200227649	BR	200011191
		EP	1175588	US	2003010185
		WO	2003004102	CA	2365227
US	3854231	US	3952658	WO	00/62004
END OF ANNEX					

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.